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Busk

Coast

Measurements



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The President read the following communication :

NOTE *on a* READY METHOD *of* MEASURING *the* CUBIC CAPACITY *of* SKULLS. By G. BUSK, F.R.S., President of the Anthropological Institute. [With two plates].

HAVING lately had occasion to take the internal capacity of a considerable number of skulls, I was induced to consider how this might be done quickly and conveniently; and having found that the simple contrivance I now bring before your notice

CHOREMOMETER - BUSK



HALF SCALE



answers every purpose, I hope it may prove equally convenient to others.

The most perfect way of ascertaining the capacity of an irregular cavity, is of course by means of filling it with water or other fluid, whose quantity is afterwards measured.

The difficulty however, of closing all the openings in a skull, and the time that would be occupied in attempting it, are such as to render this proceeding inapplicable except in very special cases.

Instead of water, several dry materials have therefore been usually employed, as sand and different sorts of seeds, such as rape, buckwheat, millet, pepper, etc. It is not in reality, perhaps, a matter of very great consequence which of these kinds of materials is employed if proper care be taken, but on the whole, I myself very much prefer fine, clean, sharp silicious sand, such, for instance, as is used in the construction of hour-glasses. I have been told by some that they find it difficult to obtain constant results with sand, but this is, I think, owing to their not having attended to one or two points as regards manipulation, to which I shall presently refer.

The skull having been filled, the sand or other material must then be either measured or weighed. Dr. Morton* describes a contrivance for measuring devised by Mr. Phillips, which no doubt would answer the purpose quite well, but seems to be more cumbrous in its make than is at all necessary.

Messrs. Barnard Davis and Thurnam† express the internal capacity in ounces avoirdupois of Calais sand, to which they assign a specific gravity of 1.425, and they reduce the ounces into cubic inches by multiplying them by 1.22.

Dr. Welcker‡ gives a table representing the conversion of ounces into cubic centimeters, having, as it would seem, adopted the plan of weighing from Davis and Thurnam. His specific gravity for the sand, however, differs slightly from theirs, being 1.422.

Tiedemann, as quoted by Dr. Thurnam computed the capacity from the weight of millet seed.

Besides the inconvenience of being obliged to have a large pair of scales and weights at hand, it appears to me that the use of weighing when we have a ready means of directly measuring is at least needless; but it is liable also to the graver objection that no two samples of sand appear to agree in specific weight, using that term, though an erroneous one, in the sense of expressing the weight of dry sand in a vessel of given capacity as

* "*Crania Americana.*"

† "*Crania Britannica,*" p. 220, 1865.

‡ "*Archiv. f. Anthrop.*" ii, 1866.

compared with water. And it is probable that the different sorts of seeds would differ still more widely in different samples, and would be especially liable to be affected by hygrometric conditions.

As regards sand, I may mention as an instance of the uncertainty I mean, that whilst of the sand used by Messrs. Davis and Thurnam 28·5 ounces filled a pint measure, the same measure would contain 29·35 ounces of that employed by me. In fact it is obvious that as the real specific gravity of silicious sand is the same as that of the quartz of which it is composed, viz., from 2·4 to 2·6, any difference from that in dry loose sand must depend upon the degree of closeness with which it is packed, and in some degree also upon the general shape of the particles. A sharp sand, that is to say one whose particles are more or less angular, will allow of their being shaken into closer contact than would be the case with particles worn more or less spherical. A fine sand also, especially if mixed with dusty particles, may be packed closer perhaps, or leave smaller interstices than a coarser one with rounded grains.

As the number required to multiply the ounces by to reduce them into cubic inches will of course vary according to the intrinsic weight of the sand, it is at once obvious that that quality is of great importance, and that there would be considerable chance of error in using sand whose weight had not been previously carefully ascertained, which would require accurate measuring and weighing by means not always, perhaps, at command.

From numerous trials, I find that the multiplier above referred to may vary from 1·22, which is that of Messrs. Thurnam and Davis (I presume for quite loose unshaken sand) to 1·01 for closely packed fine sand.

Although, therefore, in the absence of any proper means of measuring the sand or seeds, their weight may be made to serve as an indication of capacity, there can, I think, be no doubt that it is preferable to follow the method of measuring with a suitable apparatus, as being more direct, quicker, and in all respects more convenient.

That which I employ and which I propose to name a Choremometer (Plates xi and xii), is a graduated vessel, made of five pieces of glass, 3 inches square in the interior, and about 12·5 inches deep, so that it is capable of containing 108 to 110 cubic inches, which is enough for nearly all skulls. It is graduated on the different sides, so as to indicate by the height to which water, sand, or seeds fill it, the space occupied, which is represented on one side in cubic inches by lines one-ninth of an inch apart, and on the opposite column in cubic centimeters, of which a hundred correspond to 6·1 cubic inches. On another side the vessel is

graduated so as to indicate the corresponding weight in avoirdupois ounces and also in grammes of water; and on a third side the corresponding weight of the same bulk of brain substance (specific gravity 1040) including the membranes. If thought desirable, columns might also be given to represent the same weights in troy ounces. Of course having once obtained the cubic inches, all the items in the other columns may be readily computed, but time and trouble are saved by the observer being able to read off at once the particulars he requires.

The dimensions of the vessel have been chosen as the most convenient for one intended to contain so much as 110 cubic inches. If narrower it would be unwieldy from its height, like Mr. Phillips', and if wider the divisions would be so near together as not to be read with the same facility.

In order to insure that the surface of the sand, etc., is level, it is convenient to use a sort of piston rather less than three inches square and fitted with a stem.

As the quantity of sand that can be introduced into a skull differs considerably according to the way in which it is introduced, it is very necessary that this should be done in a uniform manner. Two modes may be employed; in one the sand is poured in till it appears at the *foramen magnum*, when the skull is to be moved very gently and without any succession in different directions, and then more sand is to be poured in, and so on until no further quantity can be introduced.

Another method, and that which I employ as giving more constant results, is to stand the skull base upwards, on a small heap of sand in a dish of any kind, and having filled it up to the *foramen magnum* to pat it as it were forcibly with the open hands on both sides, and to continue the filling and succession till no more can be introduced and the sand stands at the level of the border of the *foramen magnum*.

In proceeding to measure the quantity, the same proceeding must in either case be adopted. If the sand has been introduced loosely and lightly, it must be gently poured into the measure and allowed as it were to find its own level without any succession or shaking whatever. But if, as I strongly advise, it is employed in the second manner, the sides of the choreometer must be patted and the sand shaken down in all possible ways until it will sink no lower.

In all cases, in short, whatever the way in which the skull itself is filled, the same must be followed in filling the measure. It is for this reason that it is highly desirable to have a vessel that will take in all the contents of the skull at once. Moreover, as the density of sand, even when carefully shaken, varies according to the bulk of the vessel containing it, it is neces-

sary that the measure should be as nearly as possible of the same dimensions as the skull.

DISCUSSION.

Professor ROLLESTON said that in his hands rape seed had proved itself a better material for cubing skulls than either sand or millet seed. Professor Wyman had given an account in detail of numerous experiments with various substances used for this purpose, in his pamphlet, "Observations on Crania," Boston, U.S.A., 1868, and he had summed up strongly against the use of sand. It was to be hoped that by a series of observations upon the relations subsisting between cubic capacity and external measurements in skulls, where both sets of measurements could be taken, some means of judging, at least approximately, of the cubic capacity would be obtained for skulls too fragile or imperfect to allow of being cubed. The weight of the skull would have to be taken in such a preliminary comparison of external and internal measurements, as furnishing something of a check upon the disturbance which differences in the thickness (and consequently the weight) of the skulls would introduce.
